SYSTEMATIC STUDY OF HIGH p_T HADRON SPECTRA IN pp, pA AND AA COLLISIONS FROM SPS TO RHIC ENERGIES. *

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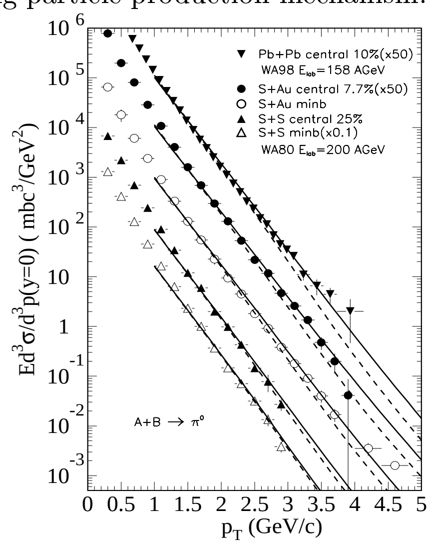
In this paper, we have analysed systematically large p_T hadron spectra in $p+p$, $p+A$ and $A+A$ collisions from CERN SPS to BNL RHIC energies within a pQCD parton model. We found that both the initial k_T in $p+p$ collisions and the k_T broadening due to multiple parton scattering in $p+A$ collisions are important to describe the experimental data within the parton model calculations. The value of initial k_T in order to fit the data is found to be larger than the conventional wisdom of $300-500$ MeV for intrinsic k_T according to the uncertainty principle. This finding is also consistent with analysis of Drell-Yan data and recent study of direct photon and pion production at around CERN SPS energy range. In both studies, one found that an intrinsic k_T of the order of 1 GeV/c is needed to describe the data within NLO parton model calculations. Since we only used LO pQCD calculation, we have to introduce some Q^2 dependence of the initial k_T induced by initial-state radiation processes. The parton model describes very well the energy and isospin dependence of the hadron spectra as shown in Fig. 1.

The parton model calculation can also describe the large p_T pion spectra in heavy-ion collisions at the CERN SPS energies very well, both the A or centrality and energy dependence. There is no evidence of proposed parton energy loss caused by dense partonic matter. Based on recent theoretical estimates of parton energy loss in dense partonic matter, one should expect a parton energy loss in the order of $dE/dx \sim 2-4$ GeV/fm. The absence of such energy loss in large p_T hadron spectra implies that either there is no such dense partonic matter formed or the life time of such medium is smaller then the mean free path of the parton interaction inside such a medium. It also tells us that the hadronic matter which must have existed for a period of time in heavy-ion collisions at the CERN SPS will not cause apparent energy loss or jet quenching effect. Therefore, if one observes suppression of high p_T hadrons at the BNL RHIC energy, it will unambiguously reflect an initial condition very different from what has been achieved at the CERN SPS.

As we have proposed earlier, measurement of two-particle correlation in azimuthal angle in the transverse plane should be able to distinguish these models from parton model. In the parton model, jets are always produced in pairs and back-to-back in the transverse plane. High p_T particles from jet fragmentation should then have strong back-to-back correlation. Neither hydro-dynamical model nor multiple scattering of string end-points can give such correlation. If such correlation is seen, one can then study the p_T dependence of the correlation to find out at what p_T value the correlation disappears. One can then at least quantify above what p_T value thermal-hydro model can be ruled out as the underlying particle production mechanism.



Parton model calculation of π_0 spectra at SPS compared to data. The soid lines are with initial parton scattering teh dashedlines are without.

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